Waterborne Diseases

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Waterborne Disease Outbreaks

In the United States, 127 drinking water outbreaks, most of them associated with groundwater systems, were reported to CDC from 1990 through 1998. The number of outbreaks has declined over the last 20 years, probably as a result of actions by the U.S. Environmental Protection Agency (EPA), water utilities, and public health officials; however, changes in reporting practices may also have contributed to this trend.

World Water Issues

Paul R. Hunter, consultant medical microbiologist and director of the Chester Public Health Laboratory and honorary professor of epidemiology and public health at the University of Central Lancashire, presented World Health Organization data that showed high morbidity and death rates worldwide due to consumption of unsafe drinking water. Currently, about 20% of the world's population lacks access to safe drinking water, and more than 5 million people die annually from illnesses associated with unsafe drinking water or inadequate sanitation. If everyone had safe drinking water and adequate sanitation services, there would be 200 million fewer cases of diarrhea and 2.1 million fewer deaths caused by diarrheal illness each year.

Dr. Hunter noted the wide variety of microbes recognized since 1980 as waterborne disease agents, including *Cryptosporidium*, *Cyclospora*, *Escherichia coli* O157:H7, *Legionella*, *Helicobacter pylori*, hepatitis E virus, *Toxoplasma*, and others. The factors that contribute to the emergence and spread of disease agents are ecologic changes (including those caused by human activity), international travel and commerce, technology, human demographics and behavior, microbial evolution, and the breakdown of public health systems. Dr. Hunter warned that global freshwater consumption rose sixfold between 1900 and 1995, and that this places increasing stress on available drinking water reserves. This increasing stress will result in ecologic damage from over-extraction from rivers, saltwater intrusion into groundwater from over-extraction of groundwater, more highly contaminated water sources, and the potential struggle for access to water. Dr. Hunter concluded his presentation by discussing the threat of biological terrorism via microbes that could be used for deliberate contamination of the water supply.

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Methodologic Issues in the Evaluation of Waterborne Disease

Jack M. Colford, assistant professor of epidemiology, at the University of California-Berkeley, discussed methods for estimating the incidence of infectious diseases attributable to the consumption of tap water. In a previously published study, investigators in Canada compared the incidence of gastroenteritis in homes with and without a reverse-osmosis filter. The study showed that 35% of gastrointestinal illness in the community studied was attributable to drinking water. The study was randomized, but participants knew in which group they were enrolled. As a partial consequence of this study, when Congress amended the Safe Drinking Water Act in 1996, it required that EPA and CDC develop a national estimate of waterborne disease occurrence in the United States. In response, CDC and EPA jointly convened a series of workshops and consensus panel meetings to develop an approach to meet this mandate.

As a result of these meetings, EPA and CDC are supporting several studies, the largest of which will be a randomized, blinded, placebo-controlled trial, involving treatment of in-house drinking water. A pilot study of this intervention trial was recently conducted with residents in 74 homes in northern California; some residents received an active water treatment device containing a 1-µm filter and ultraviolet (UV) light for disinfection, and others received a placebo—the same device without a filter or UV light. Results from this study and a similar study in Australia should be released in fall 2000. Other studies employing the same design will include persons using a groundwater system in Davenport, Iowa; HIV-positive persons in San Francisco; and elderly persons in Sonoma, California. The results of these studies will be used to estimate the percentage of gastrointestinal disease associated with different types of drinking water. When compared with the total prevalence of gastrointestinal disease in the United States, these results will provide an estimate of the national burden of waterborne disease caused by drinking water.

Biofilms

Mark W. LeChevallier, director of research at the American Water Works Service Company, discussed health concerns regarding biofilms in the drinking water distribution system. Biofilms are coatings of organic and inorganic materials in pipes that can harbor, protect, and allow the proliferation of several bacterial pathogens, including *Legionella* and *Mycobacterium avium* complex (MAC). Factors that affect bacterial growth on biofilms include water temperature, type of disinfectant and residual concentration, assimilable organic carbon level, biodegrad-

able organic carbon level, degree of pipe corrosion, and treatment/distribution system characteristics. Chloramine is considerably more effective than chlorine for controlling *Legionella* in biofilms, presumably because chloramine is more stable and thus less reactive than chlorine, allowing it to penetrate the biofilm more deeply.

An important factor in distribution system contamination and bacterial growth on biofilms is transient water pressure fluctuations that create pressure waves that pass through pipes in the distibution system. During the negative portion of the pressure wave, a substantial amount of contaminated water (>1 gal per minute) from the outside can be pulled into pipes through a small leak. This problem is aggravated when sewer lines are placed close to water pipes. Dr. LeChevallier stated that a number of waterborne disease outbreaks have been linked to distribution system deficiencies. Among the agents of nosocomial waterborne disease is MAC. This opportunistic bacterial pathogen lives in water, is resistant to water disinfection (much more so than *Giardia* cysts), and grows in pipe biofilms.